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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference AP1012PCT	FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/CA2004/001552	International filing date *(day/month/year)* 23 August 2004 (23-08-2004)	Priority date *(day/month/year)* 15 October 2003 (15-10-2003)
International Patent Classification (IPC) or national classification and IPC IPC(7): H04B 10/08, H04B 17/00		
Applicant EXFO ELECTRO-OPTICAL ENGINEERING INC ET AL		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. [ ] *(sent to the applicant and to the International Bureau)* a total of 18 sheets, as follows:
      - [ ] sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      - [ ] sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. 1 and the Supplemental Box.

   b. [ ] *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) ,containing a sequence listing and/or tables related thereto, in électronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

[X] Box No.I	Basis of the report
[ ] Box No. II	Priority
[ ] Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
[ ] Box No. IV	Lack of unity of invention
[X] Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
[ ] Box No. VI	Certain documents cited
[ ] Box No. VII	Certain defects in the international application
[ ] Box No. VIII	Certain observations on the international application

Date of submission of the demand 15 April 2005 (15-04-2005)	Date of completion of this report 12 October 2005 (12-10-2005)
Name and mailing address of the IPEA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001(819)953-2476	Authorized officer Leah Smith (819) 956-9966

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/CA2004/001552

Box No. I Basis of the report

1. With regard to the **language**, this report is based on:

[X] the international application in the language in which it was filed

[ ] a translation of the international application into , which is the language of a translation furnished for the purposes of:

[ ] international search (Rules 12.3(a) and 23.1(b))

[ ] publication of the international application (Rule 12.4(a))

[ ] international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

[ ] the international application as originally filed/furnished

[X] the description:

[X] pages 1 as originally filed/furnished

[X] pages* 2-11 received by this Authority on 19 August 2005 (19-08-2005)

[ ] pages* received by this Authority on

[X] the claims:

[ ] pages as originally filed/furnished

[ ] pages* as amended (together with any statement) under Article 19

[X] pages* 12-17 received by this Authority on 19 August 2005 (19-08-2005)

[ ] pages* received by this Authority on

[X] the drawings:

[ ] pages as originally filed/furnished

[X] pages* 1/1-1/2 received by this Authority on 19 August 2005 (19-08-2005)

[ ] pages* received by this Authority on

[ ] a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. [ ] The amendments have resulted in the cancellation of:

[ ] the description, pages

[ ] the claims, Nos.

[ ] the drawings, sheets/figs

[ ] the sequence listing *(specify)*:

[ ] any table(s) related to sequence listing *(specify)*:

4. [ ] This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

[ ] the description, pages

[ ] the claims, Nos.

[ ] the drawings, sheets/figs

[ ] the sequence listing *(specify)*:

[ ] any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-27	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	1-27	YES
	Claims	NONE	NO
Industrial applicability (IA)	Claims	1-27	YES
	Claims	NONE	NO

2. Citations and explanations (Rule 70.7)

The new claims on file appear to be novel, involve an inventive step, and have industrial applicability (Articles 33(2), 33(3) and 33(4) PCT).

In the prior art devices for measuring parameters of optical signals travelling along a fiber in a communication network, the measurements are generally taken by coupling or tapping the signal out of the fiber without disturbing the traffic flow in the fiber. The method and device of the present application differs from the prior art in that it temporarily physically disconnects the link between the OLT and the ONT in order to connect the measuring device in series with the optical transmission path using two connector means.

from ONTs when the fiber link is disconnected, thereby preventing reception of the 1490-nm downstream-data signal.

Field maintenance of such FTTX installations requires low-cost and easy-to-use diagnostic test instruments to measure the signals. An example of such diagnostic test instruments is an optical power meter that can independently measure the power at the distinct downstream and upstream signal wavelengths (e.g. 1310 nm, 1490 nm, 1550 nm). During a repair call, the results of such a measurement could indicate the source of possible trouble in the network or in the end-user's connection. It is also known to use optical spectrum analyzers (OSA) to measure optical power at several wavelengths at the same time.

A disadvantage of each of these instruments is that it is a one-port device that only measures the power if the signals at the different wavelengths are propagating in the same direction along the fiber. In the case of the OSA, a further disadvantage is that the instrument is generally much too costly and complicated for routine field applications.

DISCLOSURE OF THE INVENTION

The present invention seeks to eliminate, or at least mitigate, the disadvantages of the prior art, or at least provide an alternative and, to this end, there is provided a portable instrument for measuring parameters, e.g. optical power, of analog or digital optical signals that concurrently are propagating bi-directionally in an optical transmission path between two elements, such as network elements of a passive optical network, at least one of which will not transmit its optical signals if continuity of the path is not maintained.

According to one aspect of the present invention, there is provided portable apparatus for measuring parameters of optical signals propagating concurrently in opposite directions in an optical transmission path between two elements, at least one of the elements being operative to transmit a first optical signal (S1) only if it continues to receive a second optical signal (S2) from the other of said elements. The apparatus comprises first and second connector means for connecting the apparatus into the optical transmission path in series therewith, and means connected between the first and second connector means

for propagating at least said second optical signal (S2) towards said at least one of the elements, and measuring said parameters of said concurrently propagating optical signals (S1, S2).

Where said one of the elements also receives via said optical transmission path a third optical signal (S3) at a different wavelength from that of said second optical signal (S2), the propagating and measuring means may further comprise means for measuring parameters of the third optical signal (S3).

The propagating and measuring means may provide an optical signal path between the first and second connector means for conveying at least a portion of said second optical signal (S2), therethrough for subsequent propagation to the respective one of the elements.

In embodiments of the invention which provide an optical path between the first and second connector means, the propagating and measuring means may comprise:

coupler means having first and second ports connected to the first and second connector means, respectively, and providing said optical signal path to convey a first portion to said first optical signal (S1) and second (S2) optical signal in opposite directions between said first and second connector means, the coupler means having a third port for outputting a second portion (S1') of said first optical signal (S1),

detection means for converting (at least) the portion of first optical signal portion into a corresponding electrical signal, and

measuring means for processing the electrical signal to provide an indication of said measured parameters

The coupler means may have a fourth port for outputting a portion of said second optical signal (S2), the detection means converting the second optical signal portion into a corresponding second electrical signal, and the measuring means processing both of the electrical signals to provide desired measurement values of parameters for each of the counter-propagating signals.

Where said one of the elements also normally receives via the optical transmission path a third optical signal (S3) at a different wavelength to that of said second optical signal (S2), the propagating and measuring means may

further comprise means connected to the coupler means for splitting the corresponding optical signal portion into two parts, each part comprising portions of both the second and third optical signals, and separating the two parts according to wavelength before supplying same to said detection means. The detection means may then comprise separate detectors.

The means for splitting and separating may comprise a splitter connected to the coupler for splitting the optical signal portion into two parts and filter means for separating the two parts according to wavelength.

Alternatively, the means for splitting and separating may comprise a wavelength discriminator, for example a wavelength division multiplexer connected to the coupler means for separating the second and third optical signals (S2, S3) according to wavelength before supplying same to said detection means.

The apparatus may comprise display means for displaying measured values of the parameters.

Where at least one of the optical signals comprises parts having different wavelengths, the instrument may further comprise wavelength discrimination means for distinguishing corresponding parts of the corresponding optical signal portion according to wavelength, the detection means and processing means detecting and processing the two different signal parts separately. The detection means then may comprise two detectors, each for detecting a respective one of the optical signal parts.

Where the optical signals are analog, the processing means may be arranged to extract the time-averaged optical power of the signal.

Where the optical signals comprise bursts alternating with lulls, the processing means may be arranged to extract the optical power of the bursts.

If the optical signals comprise bursty digital signals, the processing means may further be arranged to extract the optical power of the bursts averaged over the duration of the burst. More particularly, where the instrument is to be used for measuring power of optical signals comprised of "bursty" data streams (such as the ATM data signals), the detector means may be arranged to extract the power only from the data bursts and not from any intervening series of digital

zeros (i.e. lack of signal). Such bursty data streams are typical of both the upstream data sent by an optical network terminal (ONT) to an optical line terminal (OLT) of a passive optical network (PON), and by the OLT to the plurality of ONTs.

The signal processing means may be custom circuitry and/or a suitably-programmed microcomputer.

According to a second aspect of the invention, there is provided a method of measuring parameters of optical signals propagating concurrently in opposite directions in an optical transmission path between elements, at least one of the elements not transmitting its optical signals (S1) if it ceases to receive signals (S2) from the other of the elements, the method comprising the steps of (i) connecting into the optical transmission path first and second connectors of an apparatus for propagating at least a portion of the second optical signal (S2) to the one element, (ii) extracting a portion of a said first optical signal (S1) and providing a corresponding first electrical signal; and (iii) processing said first electrical signal to provide desired parameter measurements.

The step of propagating at least a portion of the second signal (S2) may include the step of connecting coupler means into the optical transmission path so as to provide an optical path through the apparatus and extracting the portion of the second optical signal from a port of the coupler means.

Where at least one of the optical signal portions comprises parts having different wavelengths, the method may further comprise the step of distinguishing the corresponding different parts of the corresponding optical signal portion according to wavelength, and the detecting and measuring steps then may detect and measure the two different signal parts separately to provide the measured parameters for each signal.

The step of distinguishing the parts may be performed by splitting the portion of the optical signal into two parts and separating the two parts according to wavelength using, for example, filter means.

Alternatively, the step of distinguishing the parts may be performed using a wavelength discriminator, for example a wavelength division multiplexer.

Where the optical signals are analog, the measurement step may extract the time-averaged optical power of the signal.

Where the optical signals comprise bursts alternating with lulls, the measuring step may extract the optical power of the bursts.

If the optical signals comprise bursty digital signals, the measuring step may extract the optical power of the bursts averaged over the duration of the burst. More particularly, where the instrument is to be used for measuring power of optical signals comprised of "bursty" data streams (such as the ATM data signals), the measuring step may extract the power only from the data bursts and not from any intervening series of digital zeros (i.e. lack of signal).

Various objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description, of a preferred embodiment of the invention which is described by way of example only with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified block schematic diagram of a portion of a passive optical network;

Figure 2 is a simplified block schematic diagram of a power meter embodying the present invention inserted into a branch of the network; and

Figure 3 is a detail view illustrating a modification.

DESCRIPTION OF PREFERRED EMBODIMENTS

A portion of a passive optical network shown in Figure 1 comprises a first element in the form of a central office optical line terminal (OLT) 10 coupled by a 1:9 splitter 12 to a plurality of other elements in the form of optical network terminals (ONT) 14/1 to 14/9, each coupled to a respective one of the nine ports of the splitter 12 by one of a corresponding plurality of optical waveguides 16/1 to 16/9. (It should be noted that, although nine terminals and a nine-port splitter are shown for convenience of illustration, there could be more or fewer in practice.) The terminals use asynchronous transfer mode (ATM) or similar

protocol to encode the downstream (OLT to ONTs) and upstream (ONTs to OLT) digital data signals. OLT 10 broadcasts to the ONTs 14/1 to 14/9 downstream data signals (S2) at a wavelength of 1490-nm and downstream cable television (CATV) signals (S3) at a wavelength of 1550-nm and, in known manner, encodes the 1490-nm signals for synchronization purposes, the encoding being decoded by the ONTs and used to permit each of the ONTs 14/1 to 14/9 to send upstream, to the OLT 10, 1310-nm digital optical data signals (S1) in its own unique time slot so as to avoid interference with signals from other ONTs connected to the same OLT 10. The cable television signals (S3) are supplied by CATV source 11 shown connected to the OLT 10 and combined with the data signals (S2) in known manner.

If they do not receive the downstream signals, and hence the synchronization information, the ONTs cannot normally transmit. For a field technician to make measurements of all three signals, therefore, it is necessary for the ONTs 14/1 to 14/9 to continue receiving the downstream signals from the OLT 10.

A test instrument 18 which allows the upstream and downstream optical signals to continue propagating, while measuring the power of the optical signals S1, S2 and S3 at all three wavelengths, will now be described with reference to Figure 2, which shows the instrument 18 connected into branch waveguide 16/9 between the splitter 12 and ONT 14/9. The test instrument 18 comprises a casing 20 having first 22 and second 24 bulkhead connector receptacles or ports shown coupled to the splitter 12 and ONT 14/9, respectively, connector receptacle 24 being connected to the ONT 14/9 by a short jumper 26.

Within the power meter casing 22, the receptacles 22 and 24 are connected to first and second ports 28 and 30, respectively, of a 2 x 2 optical coupler 32, having an approximately 80:20 splitting ratio which ratio is approximately the same at all the wavelengths to be measured (i.e. 1310 nm, 1490 nm, 1550 nm).

Thus, coupler 32 splits each of the signals S2, S3 and S1 received at ports 28 and 30, respectively, into two parts with a ratio of 80:20. The 80 per cent signal portions are each routed back to the other of the two connectors 22 and 24

while the 20 per cent signal portions S1' and S2', S3' are each routed to one of the corresponding third and fourth ports 34 and 36, respectively, of the coupler 32.

Port 34, which receives the 20 per cent portion S1' of the signal S1 from the ONT 14/9, is connected by way of a filter 62, conveniently a 1310 nm bandpass filter, to a first photodetector 38 for detecting light at wavelengths nominally at 1310 nm. Port 36, which receives signal portions S2', S3' representing 20 per cent of each of the 1490-nm and 1550-nm optical signals from the OLT 10, is coupled to a 1x2 optical splitter 40, having an approximately 90:10 splitting ratio that is approximately the same at all downstream wavelengths to be measured (i.e. 1490 nm, 1550 nm).

The 90 per cent signal portions S2" from splitter 40 are routed via the corresponding output optical fiber from the optical splitter 40 to a second bandpass filter 64, passing light within an approximately 15-nm wavelength band centered about 1490 nm and substantially attenuating light outside of this band (e.g. attenuation of greater than 40 dB at 1550 nm for digital CATV signals). The output S''' of the second bandpass filter 64 is routed to a second photodetector 42, which detects light nominally at 1490 nm.

The 10 per cent signal portions S2", S3" from splitter 40 are routed via the corresponding output optical fiber to a third bandpass filter 66, passing light within an approximately 25-nm wavelength band centered about approximately 1550 nm and substantially attenuating light outside of this band (e.g. greater than 20 dB for analog CATV signals, greater than 40 dB for digital CATV signals). The output S3''' of the third bandpass filter 66 is coupled to the third photodetector 44, which detects light nominally at 1550 nm.

The three photodetectors 38, 42 and 44 supply their corresponding electrical signals to an electronic measuring unit 46 which comprises a set of three similar amplifiers 48, 50 and 52 for amplifying the electrical signals from photodetectors 38, 42 and 44, respectively. Power detectors 54 and 56 detect power of the amplified electrical signals from amplifiers 48 and 50, respectively, and supply the power measurements to a processor unit 58 which, using an internal analog-to-digital converter, converts them to corresponding digital signals which it processes to obtain the required parameter measurements,

specifically power, and supplies the measurement information to a display unit 60 for display of the measurements in a conventional manner. The amplified signal from amplifier 52, corresponding to CATV signal S3, is supplied directly to the measurement unit 58, to provide a measure of average optical power.

Typically, the field technician will disconnect the link 16/9 to ONT 14/9 at the home/premise etc. of the end-user at an existing "connectorized" coupling. The connector on the upstream part of the link 16/9 will then be connected to a specified one (22) of the two bulkhead connectors on the instrument, and the connector on the jumper 26 will be connected to the other. Of course, if a connectorized coupling between parts of the link is available, the jumper 26 may not be needed.

While the link is disconnected, emission of the upstream data signals at wavelength 1310 nm by the ONT 14/9 will normally cease, and will then recommence when the two connectors are connected to their respective bulkhead connector receptacles 22,24 on the test instrument 18 and the ONT begins to receive the 1490 nm signal again. Measurements can then be taken.

The fact that there will be a temporary disruption in the line as the instrument 18 is inserted is not normally important, since it would normally be used in service calls where a problem has already been indicated by the customer.

Once the test instrument is inserted into the line, between the splitter 12 and the selected one of the ONTs 14/1 to 14/9 (see Figure 1), 80% portions of the downstream data and video signals S2,S3 (i.e. at 1490 nm and 1550 nm, respectively) will pass directly through to the ONT 14/9. The ONT, thus synchronized via the received data signal, will then be able to emit its upstream (i.e. 1310-nm) data signal S1, an 80% portion of which will be sent upstream to the OLT 10, the other 20% portion being diverted to the detector 38.

It will be appreciated that the ratio of the coupler 32 need not be 80:20. Embodiments of the invention may employ different ratios. Generally, lower ratios entail more attenuation in the link between the OLT and ONT while higher ratios are lead to more polarization-dependence in the measurement within the device. It should be noted, however, that preferred couplers are available

commercially that have a particular band of wavelengths for which their ratios are substantially wavelength and polarization independent.

It will be appreciated that the invention is not limited to the measurement of optical power and to power meters, but could be applied to the measurement of other parameters, such as optical spectrum, bandwidth utilization in the transmission path or link, and so on. For example, the coupler 32 could be combined with an optical spectrum analyzer (OSA) which would replace the optical splitter 40, the bandpass filters 62, 64, 66, detectors 38, 42 and 44, measuring means 46, and the display 60, and a 2 x 1 coupler be added to couple the ports 34 and 36 of the 2 x 2 coupler 32 to the single input port of the OSA, thereby combining the two 20% signal portions.

It will also be appreciated that the 2 x 1 coupler inherently will introduce a loss, typically of 50% or more. Of course, instead of the OSA, an alternative single-port device coupled to a 2 x 1 coupler could replace the components 38 – 66 of Figure 2.

The bandpass filter 62 serves as a discrimination filter and is desirable to avoid undesired effects caused by optical back reflection of the 1550 nm signal which can be acute when measurements are taken close to the OLT 10. It may be omitted, however, if the apparatus will normally be used close to the ONT terminal(s).

As illustrated in Figure 3, which shows part of a modified instrument 18*, the splitter 40 and bandpass filters 64 and 66 may be replaced by a wavelength demultiplexer 68 (e.g. a low optical crosstalk WDM coupler) which separates the signal portions S2' and S3' according to their respective wavelengths and supplies the separated signals portions S2" and S3" to the detectors 42 and 44, respectively. It will be noted that Figure 3 omits the bandpass filter 62, but it may be included for the reasons discussed above.

The electronic processing unit 46 may be digital rather than analog, in which case it could be a suitably programmed microcomputer.

INDUSTRIAL APPLICABILITY

Portable test instruments embodying the present invention may be inexpensive and easy-to-use. Ease of use is especially critical when they are used for testing FTTX networks since the maintenance field technicians are generally the same personnel who maintain wire telephone connections and rarely have had significant training in fiber-optic technology.

Although an embodiment of the invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only and not to be taken by way of the limitation, the spirit and scope of the present invention being limited only by the appended claims.

CLAIMS

1. Portable apparatus for measuring parameters of optical signals propagating concurrently in opposite directions in an optical transmission path (16, 16/1,..., 16/9) between two elements (10, 14/1...14/9), at least one (14/1...14/9) of the elements being operative to transmit a first optical signal (S1) only if it continues to receive a second optical signal (S2) from the other (10) of said elements, the instrument being characterized by first and second connector means (22, 24) for connecting the instrument into the optical transmission path in series therewith, and means (32, 38, 46) connected between the first and second connector means for propagating at least said second optical signal (S2) towards said at least one (14) of the elements, and measuring said parameters of said concurrently propagating optical signals (S1, S2).

2. Apparatus according to claim 1, characterized in that the propagating and measuring means (32, 38, 46) provides an optical signal path between the first and second connector means (22, 24) for conveying at least a portion of said second optical signal (S2).

3. Apparatus according to claim 2, characterized in that the propagating and measuring means (32, 38, 46) comprises:

coupler means (32) having first and second ports (28, 30) connected to the first and second connector means (22, 24), respectively, to provide said optical signal path to convey said first (S1) and second (S2) optical signals in opposite directions between said first and second connector means (22, 24), and a third port (34) for supplying a portion (S1') of said first optical signal (S1),

detection means (38; 38, 42; 38, 42, 44) for converting at least the first optical signal portion (S1') into a corresponding electrical signal, and

measuring means (46) for processing the electrical signal to provide an indication of said measured parameters.

4. Apparatus according to claim 3, characterized in that the coupler means (32) has a fourth port (36) for supplying a portion (S2') of said second optical signal (S2), the detection means (38; 38, 42; 38, 42, 44) also converting at least part of the second optical signal portion (S2') into a corresponding second electrical signal, and the measuring means (46) processing both of the electrical signals to provide desired measurement values of parameters for each of the counter-propagating signals.

5. Apparatus according to claim 1, characterized in that where said one of the elements (14/1,..., 14/9) also receives via said optical transmission path a third optical signal (S3) at a different wavelength from that of said second optical signal (S2), the propagating and measuring means (46) further comprises means (40, 44, 52, 58; 44, 58, 68) for measuring parameters of the third optical signal (S3).

6. Apparatus according to claim 4, characterized in that where said one of the elements (14/1,..., 14/9) also normally receives via the optical transmission path a third optical signal (S3) at a different wavelength to that of said second optical signal (S2), the propagating and measuring means (46) further comprises a splitter (40) connected to the coupler means (32) for splitting a corresponding optical signal portion (S2', S3') into two parts (S2", S3"), each comprising portions of both the second and third optical signals, and filter means (64, 66) coupled to the splitter (40) for separating the two parts according to wavelength before supplying same to said detection means (38, 42, 44).

7. Apparatus according to claim 4, characterized in that where said one of the elements (14/1,..., 14/9) also normally receives via the optical transmission path a third optical signal (S3) at a wavelength different from that of said second optical signal (S2), said propagating and measuring means comprises a wavelength disoriminator (68) connected to the coupler (32) for separating at least a portion (S2', S3') of the combined second and third optical signals (S2, S3)

according to wavelength to obtain corresponding separate portions (S2", S3") and supplying same to said detection means (38, 42, 44).

8. Apparatus according to any of claims 1 to 7, characterized in that the measuring means comprises a separate detector (38, 42, 44) for each of the measured optical signal portions.

9. Apparatus according to any one of claims 1 to 8, characterized in that where one of the optical signals is analog, the measuring means (46) is arranged to extract the time-averaged optical power of the signal.

10. Apparatus according to any one of claims 1 to 8, characterized in that where one (S1) of the optical signals comprises bursts of digital data alternating with lulls, the measuring means (46) is arranged to extract the average of the optical power averaged over the duration of the individual bursts.

11. Apparatus according to any one of claims 1 to 10, characterized in that the measuring means (46) comprises custom circuitry.

12. Apparatus according to any of claims 1 to 10, characterized in that the measuring means (46) comprises a suitably-programmed microcomputer.

13. Apparatus according to any one of claims 1 to 12, characterized in that said measuring means further comprises display means (60) for displaying the parameter measurements.

14. A method of measuring parameters of at least one of optical signals propagating concurrently in opposite directions in an optical transmission path (16, 16/1,..., 19/9) between two elements (10, 14/1...14/9), at least one (14/1...14/9) of the elements being operative to transmit a first optical signal (S1) only if it continues to receive a second optical signal (S2), the method being characterized by the steps of:

connecting first and second connector means (22, 24) of an instrument into the optical transmission path in series therewith,

using the instrument to propagate at least said second optical signal (S2) towards said at least one (14) of the elements, and

measuring said parameters of said concurrently propagating optical signals.

15. A method according to claim 14, characterized in that the instrument provides an optical signal path between the first and second connector means (22, 24) for at least said second optical signal (S2).

16. A method according to claim 15, characterized in that the instrument has a coupler means (32) having first and second ports (28,30) connected to the first and second connector means (22, 24), respectively, to provide said optical signal path for conveying said first (S1) and second (S2) optical signals in opposite directions between said first and second connector means (22, 24), and a third port (34) for a portion (S1') of said first optical signal (S1) propagating in said optical signal path, the method comprising the steps of:

extracting said portion (S1') of said first optical signal (S1) from said third port of the coupler means,

converting the first optical signal portion (S1') into a corresponding first electrical signal, and

processing the first electrical signal to provide an indication of said measured parameters.

17. A method according to claim 16, characterized by the steps of

extracting from a fourth port (36) of the coupler (32) a portion (S2') of said second optical signal (S2) propagating in the optical signal path;

converting the second optical signal portion (S2') into a corresponding second electrical signal; and

processing said first and second electrical signals to provide the desired parameters for each of the counter-propagating optical signals.

18. A method according to claim 14, 15, 16 or 17, characterized in that where said one of the elements (14/1,..., 14/9) also receives via the optical transmission path a third optical signal (S3) at a wavelength different from that of said second optical signal (S2), the measuring step also measures parameters of the third optical signal (S3).

19. A method according to claim 17, characterized in that where said one of the elements (14/1,..., 14/9) also receives via the optical transmission path a third optical signal (S3) co-propagating with the said second optical signal (S2) at a wavelength different from that of the said second optical signal (S2), the measuring step includes the steps of splitting a portion of the co-propagating optical signals into two parts, each comprising portions of the second and third optical signals (S2, S3), separating each of the two parts according to wavelength, converting said parts into said second electrical signal and a third electrical signal, respectively, and also processing the third electrical signal to obtain parameters of the third optical signal (S3).

20. A method according to claim 17, characterized in that where said one of the elements (14/1,..., 14/9) also receives via the optical transmission path a third optical signal (S3) co-propagating with the said second optical signal (S2) at a wavelength different from that of the said second optical signal (S2), said measuring step employs a wavelength discriminator (68) connected to the coupler (32) for splitting a portion of the co-propagating optical signals into two parts each corresponding to a respective one of the second and third optical signals, , converting the parts to said second electrical signal and a third electrical signal, and also processing the third electrical signal to obtain parameters of said third optical signal (S3).

21. A method according to any one of claims 14 to 20, characterized in that the detection step uses a separate detector (38, 42, 44) for each of the measured optical signals.

22. A method according to any one of claims 14 to 21, <u>characterized in that</u> where one of the optical signals is analog, the detection and processing derives the time-averaged optical power of the signal.

23. A method according to any one of claims 14 to 21, <u>characterized in that</u> where one (S1) of the optical signals comprises bursts of digital data alternating with lulls, the detection and processing derives the average of the optical power averaged over the duration of the individual bursts.

24. A method according to any one of claims 14 to 23, <u>characterized in that</u> the processing is performed using custom circuitry.

25. A method according to any of claims 14 to 23, <u>characterized in that</u> the processing is performed using a suitably-programmed microcomputer.

26. A method according to any one of claims 14 to 25, <u>further characterized by</u> the step of displaying the parameter measurements.

27. A method according to any one of claims 14 to 26, <u>characterized in that</u> the measurements are performed upon optical signals propagating concurrently in opposite directions in an optical transmission path between network elements in a passive optical network.

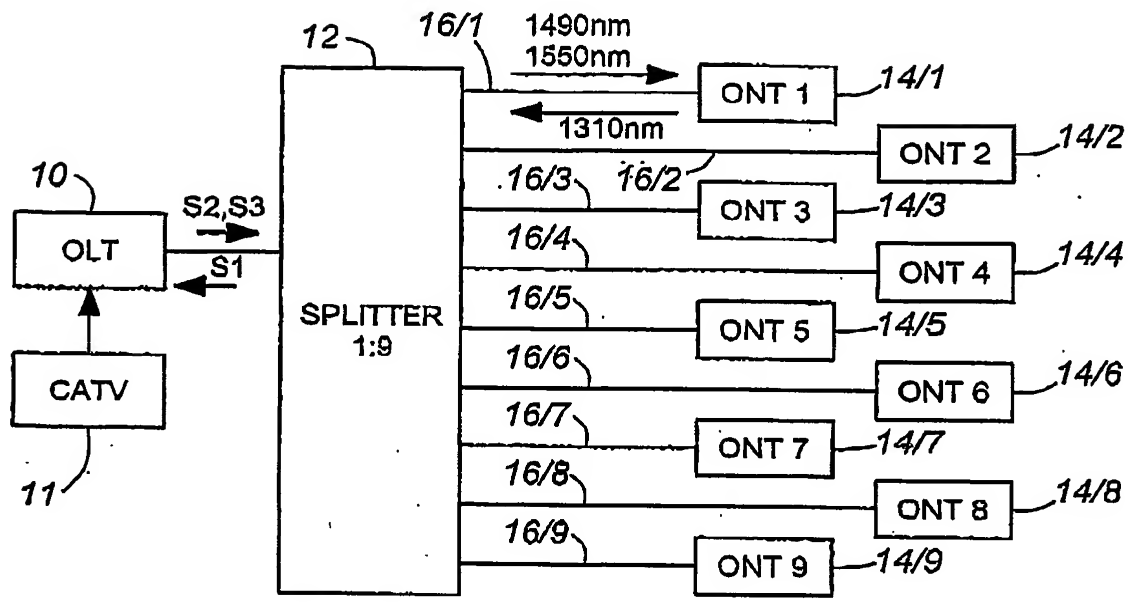
12
16/1
1490nm
1550nm
1310nm
ONT 1
14/1
ONT 2
14/2
10
16/3
16/2
OLT
S2,S3
S1
ONT 3
14/3
16/4
ONT 4
14/4
SPLITTER
1:9
16/5
ONT 5
14/5
CATV
16/6
ONT 6
14/6
16/7
ONT 7
14/7
11
16/8
ONT 8
14/8
16/9
ONT 9
14/9

FIG. 1

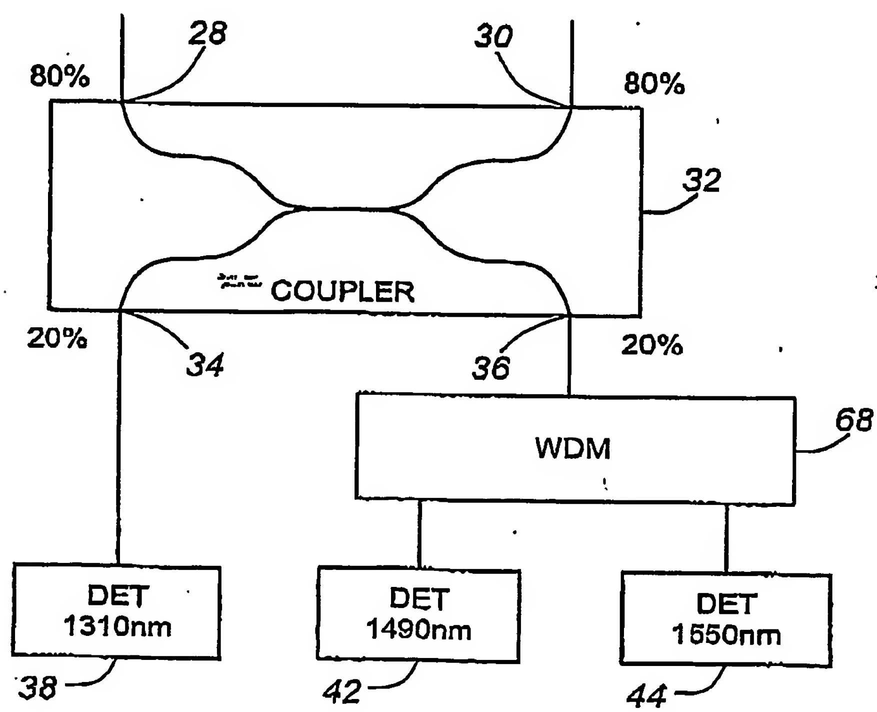
28
30
80%
80%
32
COUPLER
20%
20%
34
36
68
WDM
DET
1310nm
DET
1490nm
DET
1550nm
38
42
44

FIG. 3

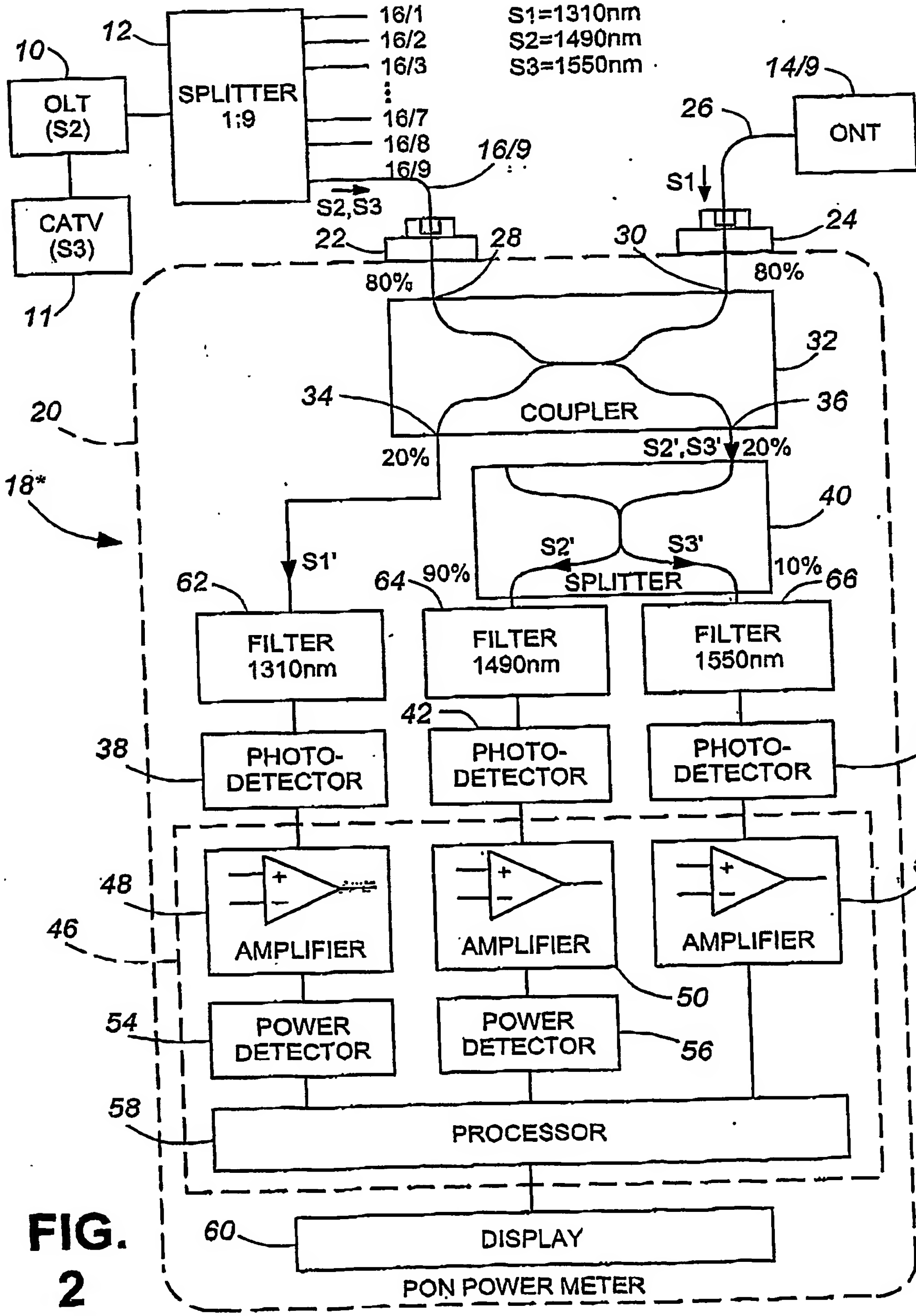
OLT (S2)
CATV (S3)
SPLITTER 1:9
16/1
16/2
16/3
16/7
16/8
16/9
S1=1310nm
S2=1490nm
S3=1550nm
ONT
14/9
10
11
12
26
S1
S2,S3
22
28
30
24
80%
80%
COUPLER
32
34
36
20%
S2',S3'
20%
20
18*
SPLITTER
S2'
S3'
40
S1'
90%
10%
62
64
66
FILTER 1310nm
FILTER 1490nm
FILTER 1550nm
42
38
44
PHOTO-DETECTOR
PHOTO-DETECTOR
PHOTO-DETECTOR
48
46
52
AMPLIFIER
AMPLIFIER
AMPLIFIER
50
54
POWER DETECTOR
POWER DETECTOR
56
58
PROCESSOR
60
DISPLAY
PON POWER METER

FIG. 2